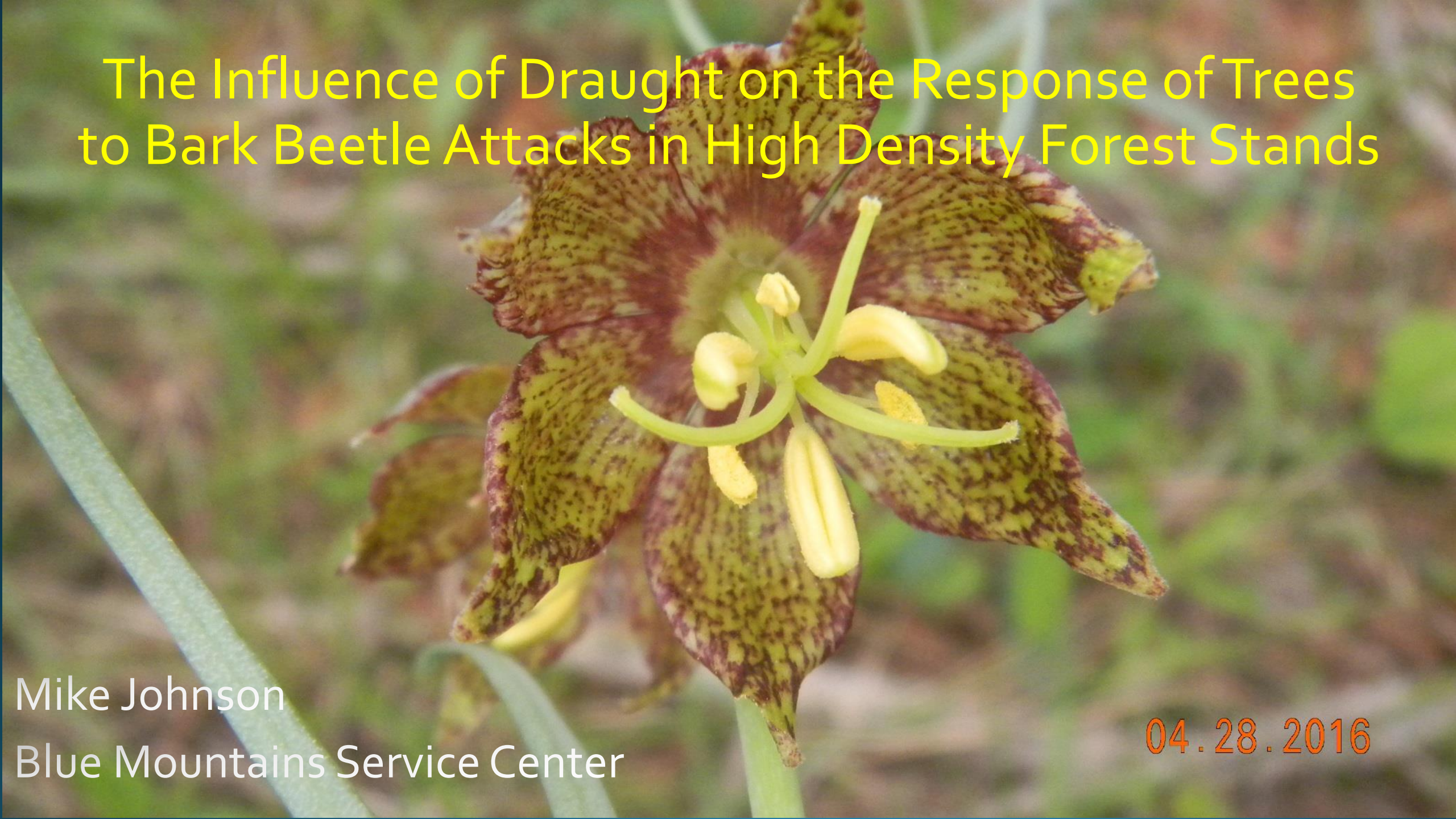
The Influence of Draught on the Response of Trees to Bark Beetle Attacks in High Density Forest Stands



Mike Johnson

Blue Mountains Service Center

04.28.2016

Stand Level Symptoms of Douglas-fir Mortality (Observed in 2016, South of Heppner)

- Individuals & pockets of recently killed Douglas-fir over 300+ acres
- Pockets of mortality with 10-20-40-60-or more trees
- Affected trees with red necrotic foliage

Stand Conditions

- Douglas-fir/common snowberry plant association
- Stand density exceeds lower limit of the self thinning zone
  - current stand density range from 180 to 340 sq. ft. of basal area per acre
- Two storied structure
  - Individuals and small groups of widely space older overstory ponderosa pine reflecting the structure of the previous cohort/stand embedded in…
  - Densely-stocked uniformly-spaced younger Douglas-fir forming the matrix

Flaked Bark: Woodpecker Activity

Pouch Fungus

Flatheaded Woodborers

- Some dead Douglas-firs with larval galleries encircling entire circumference of bole
- Some dead Douglas-firs with just a strip of the bole with larval galleries
- Some dead Douglas-firs without woodborer activity
- No Douglas-fir beetle galleries


Step Back and Revisit the Symptoms


Variable Crown Symptoms

Scott Schwartz and I Return with Fallers


Only Flatheaded Woodborers Up the Bole
No Douglas-fir Beetle Galleries
04.28.2016

Douglas-fir Pole Beetle on Bole at Base of Crown

- Egg Galleries:
  - 1-2 inches long
  - Follows grain of the wood
  - 2-branched
  - Originating from a central entrance chamber
  - May lightly etch, but does not score or engrave, the sapwood
- Larval Galleries:
  - Extend away from the egg gallery
  - Then turn up to parallel the grain above the entrance chamber or turn down to parallel the grain below the entrance chamber

Douglas-fir Engraver

- Egg Galleries:
  - single egg gallery emanating from an entrance chamber at one end
  - May construct branched egg galleries similar to S. monticolae
  - Score or engrave the sapwood
- Larval Galleries:
  - extend away from the egg gallery
  - then turn up to parallel the grain above the entrance chamber or turn down to parallel the grain below the entrance chamber

Scolytus monticolae

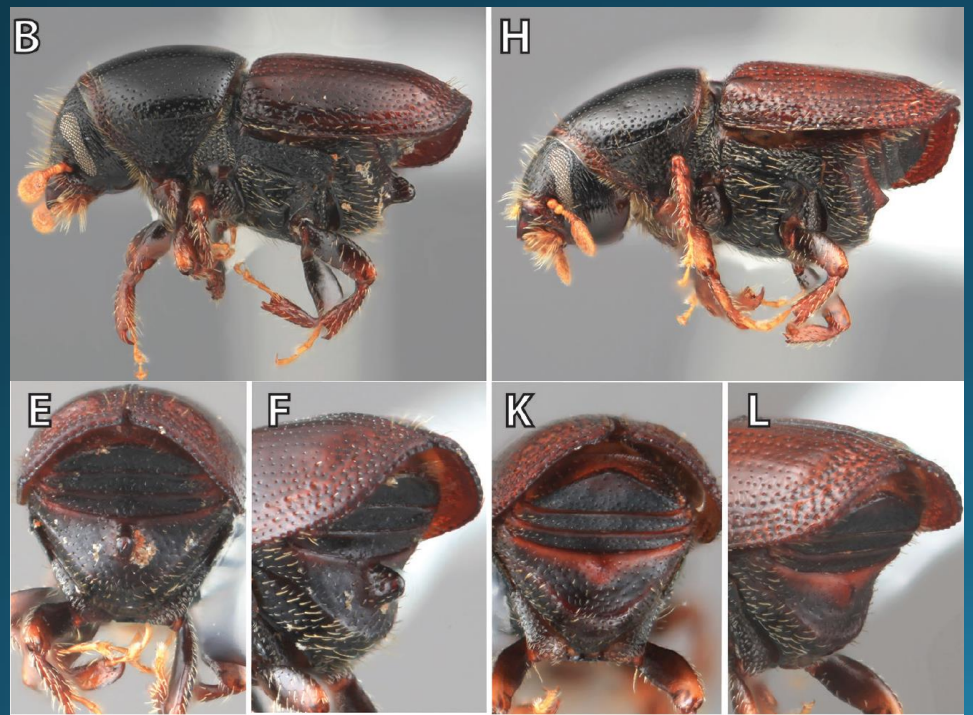
- Egg Galleries:
  - Follow the grain of the wood
  - 1-3.5 inches long
  - Two branched, and originate from a central entrance chamber
  - Score or engrave the sapwood
- Larval Galleries:
  - Extend away from the egg gallery
  - Then turn up to parallel the grain above the entrance chamber or turn down to parallel the grain below the entrance chamber

Further Signs of Engraver Beetles

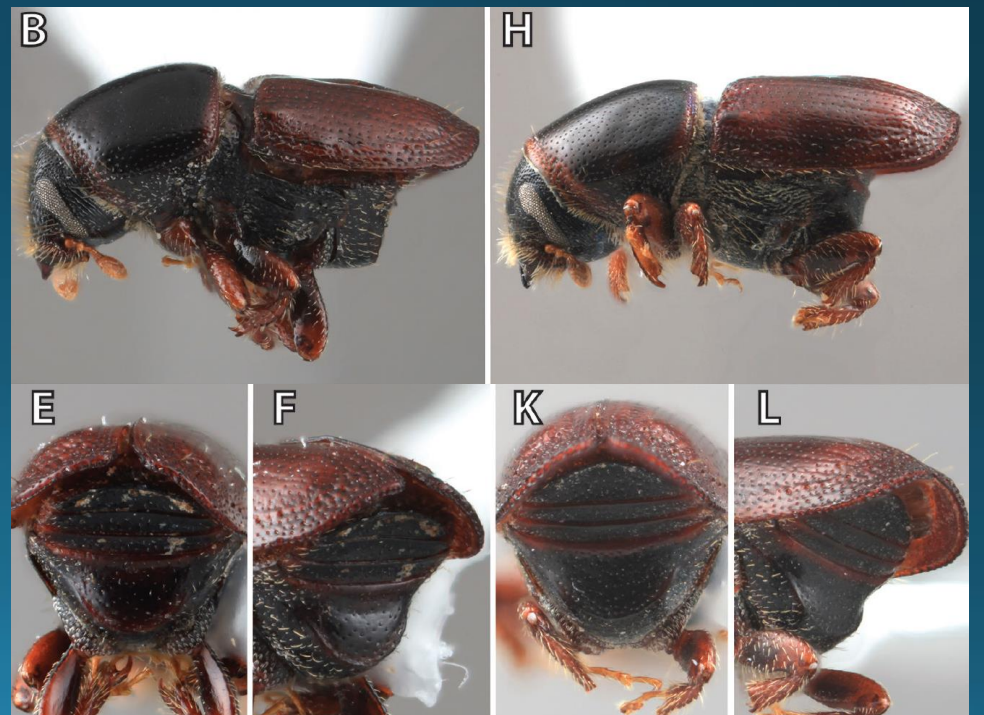
- We found exoskeletons of dead Douglas-fir engraver underneath the bark of affected trees
- We collected branch samples and brought them back to the lab
- We monitored over several days and noted emergence of Scolytus monticolae.

From: Smith and Cognato 2014. A taxonomic monograph of Nearctic Scolytus Geoffroy (Coleoptera, Curculionidae, Scolytinae)

Douglas-fir engraver



Scolytus monticolae



Predisposing Factors

- Normally limited water supplying capacity of the site
- Competition induced moisture stress
- Drought induced moisture stress

Mollisols

- Characteristically form under grass
- In climates that have a moderate to pronounced seasonal moisture deficit

-United States Department of Agriculture

Douglas-fir Engraver Host Selection

- Attracted to and attacks weakened, dying or recently dead Douglas-fir
- Prefers thin barked and sun exposed branches
- Colonization occurs in host trees under high plant moisture stress during seasons with progressively depleted soil moisture contents
- When tissue water potentials reach a threshold of 29 atm or lower which happens only in extremely droughty years

Douglas-fir Engraver Host Selection cont.

- Perception of monoterpenes alone do not stimulate attacks by DFE
- DFE attacks branches of moisture stressed DF only if they contain sufficiently high concentrations of ethanol
- Accumulation of ethanol in branches and needles is associated with severe tissue drying

Ethanol Accumulation in Stressed Branches

- Membranes of cellular organelles can break and leak their contents as tissues dry in moisture stressed plants
- Transpirational cooling declines in moisture stressed plants
- This increases tissue temperatures and likelihood of heat injury to cellular membranes
- Vacuole membranes damaged by heat and/or drying may be damage and release their acidic contents
- Acidification of the cytoplasm can drop pH low enough to activate pyruvate decarboxylase and initiate ethanol synthesis.

Treatment Considerations/Prioritization

- Water supplying capacity of the site
  - AWHC (f) soil attributes: type, texture, depth, etc.
  - Moisture input: when and how received
- Species composition
  - Ecophysiological characteristics/traits, example > PP & DF
- Competition
  - Moisture demand
  - Photosynthetic surface area
  - Allocation of photosynthate to defense and maintaining turgor of resin cells
- Periodic/cyclic/infrequent droughty conditions
  - Affect on moisture availability, transpirational stream, heat damage, ethanol production relative to stand density
- Predicted future conditions

Fir Engraver, *Scolytus ventralis*

- From: Smith SM, Cognato AI (2014) A taxonomic monograph of Nearctic *Scolytus* Geoffroy (Coleoptera, Curculionidae, Scolytinae). ZooKeys 450: 1–182. doi: 10.3897/zookeys.450.7452

Fir Engraver egg and larval galleries

Fir engraver galleries

Factors that predispose hosts to damage or mortality from fir engraver

- Root Disease
- Competition
- Drought?
- Protracted Drought!
- (related to host biology and host selection behavior)

2018 Draft ADS-Fir Engraver

Forest Health Protection, Pacific Northwest Region

2018 Aerial Survey Update

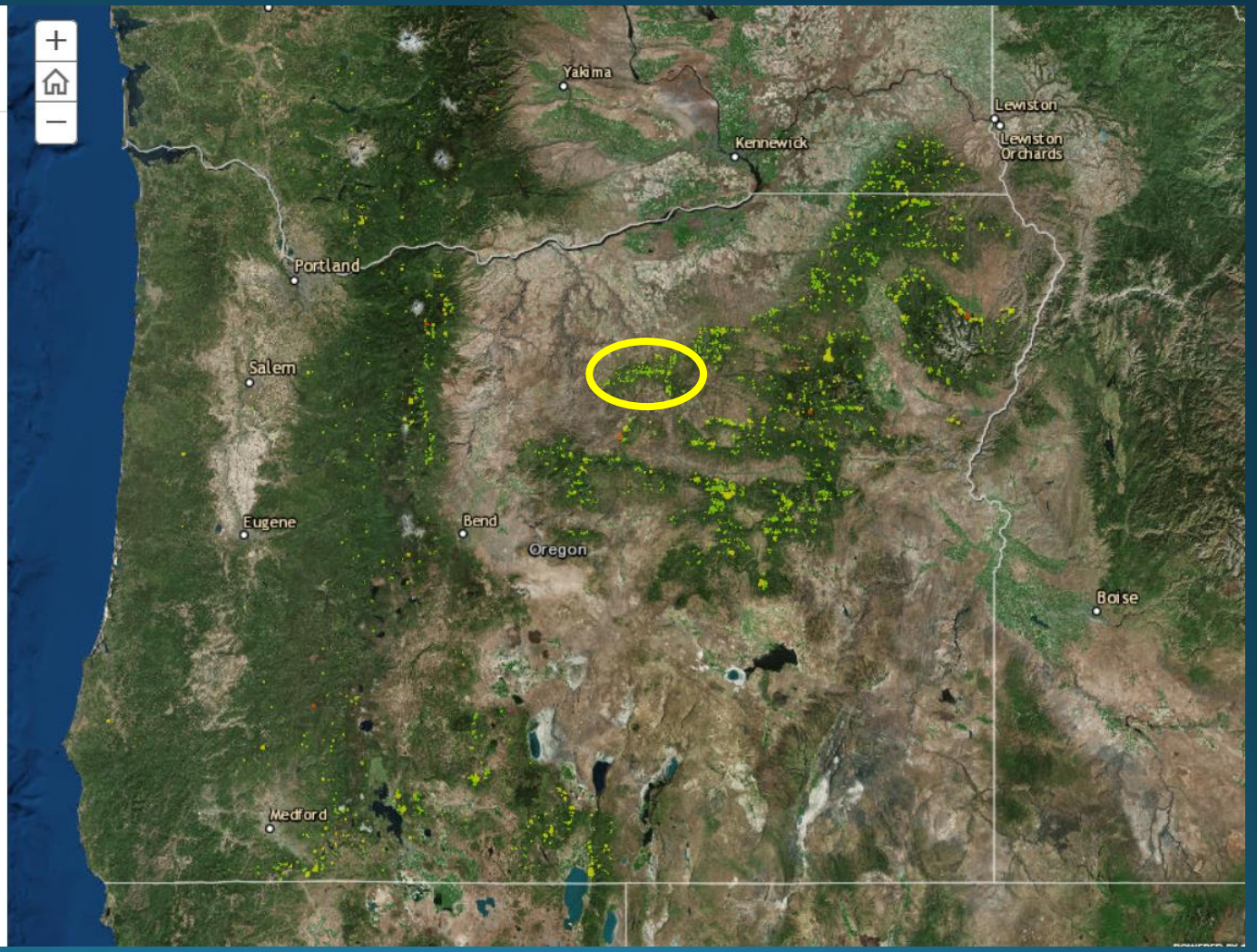
Tussock moth defoliation in the Blue Mountains.

Results - Fir Engraver Beetle

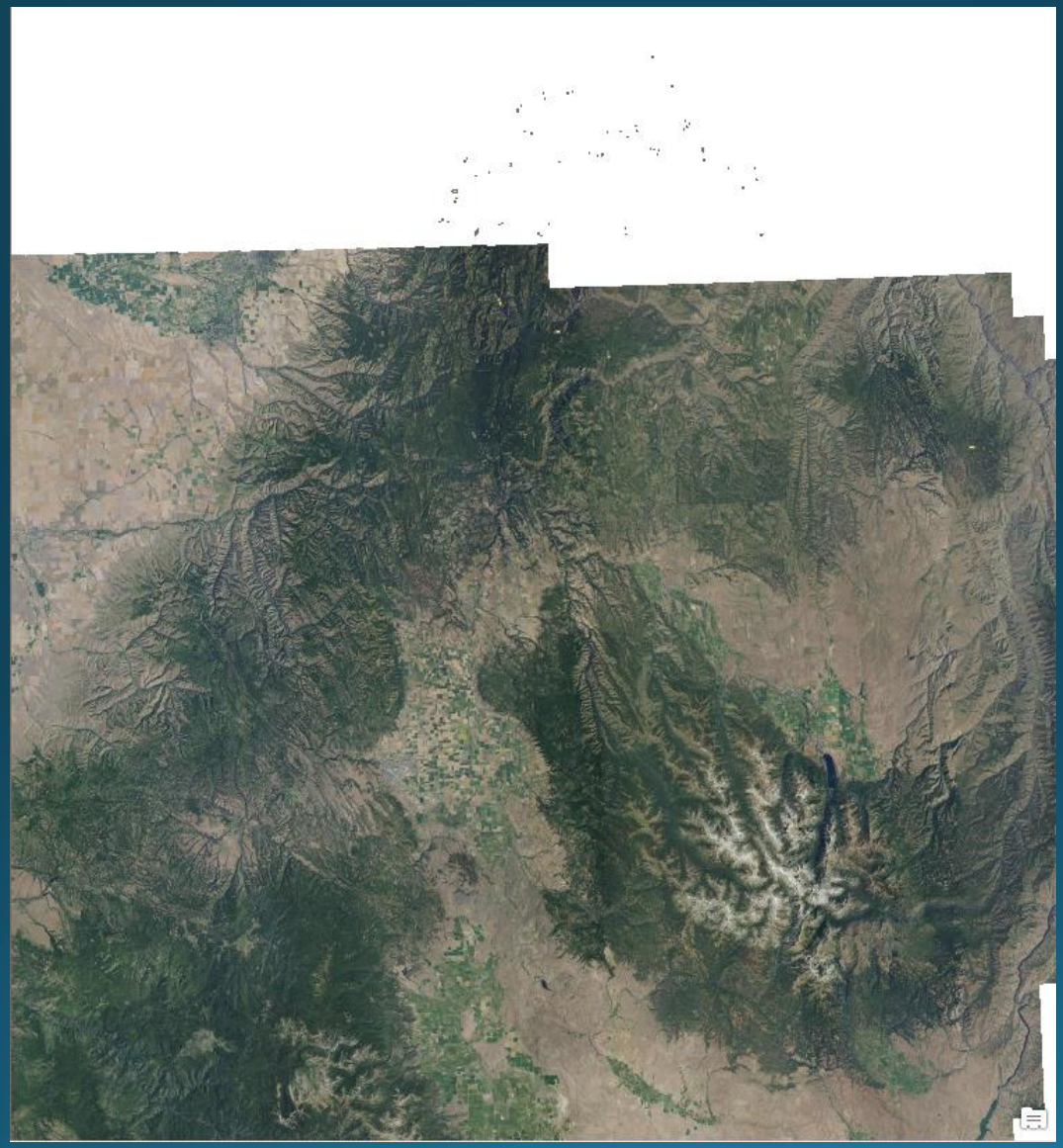
Large areas of fir mortality have been observed throughout the Blue Mountains and eastern Washington this year, with roughly 250,000 acres with mortality recorded in 2018.

Cedar mortality

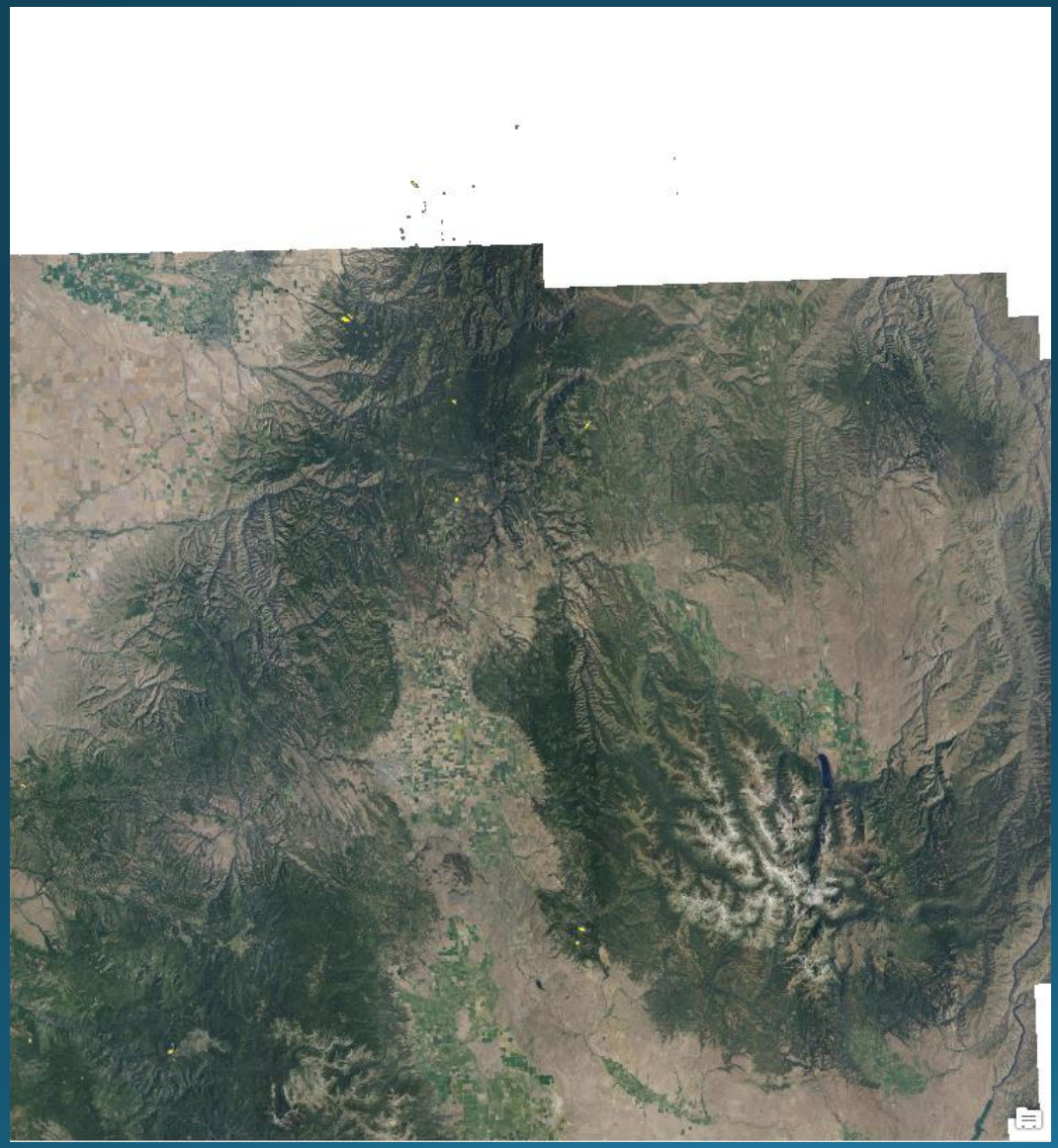
More dying western redcedars were mapped this year than in previous years of survey, and were mostly observed in northwest Washington.



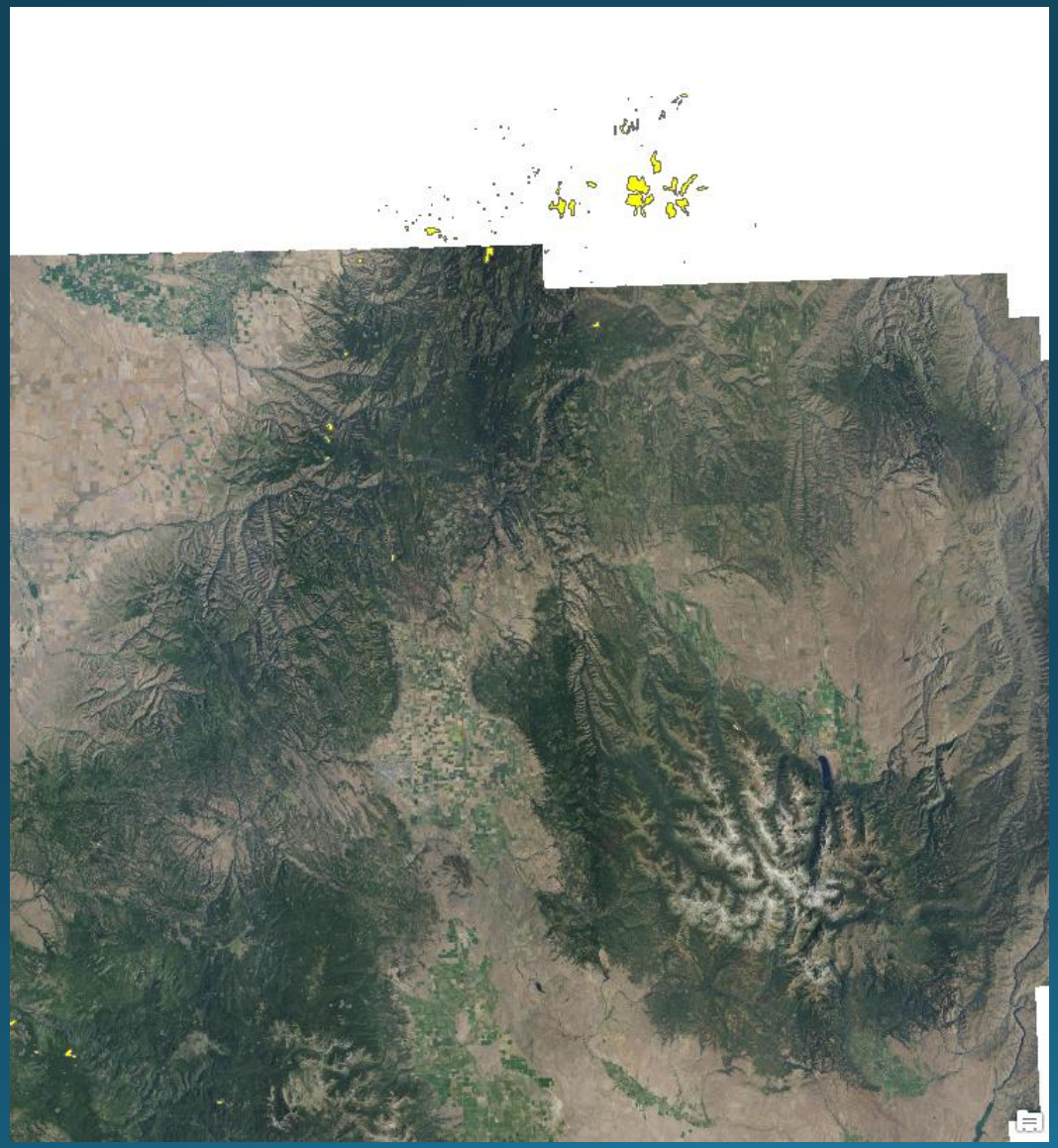
2012



2013

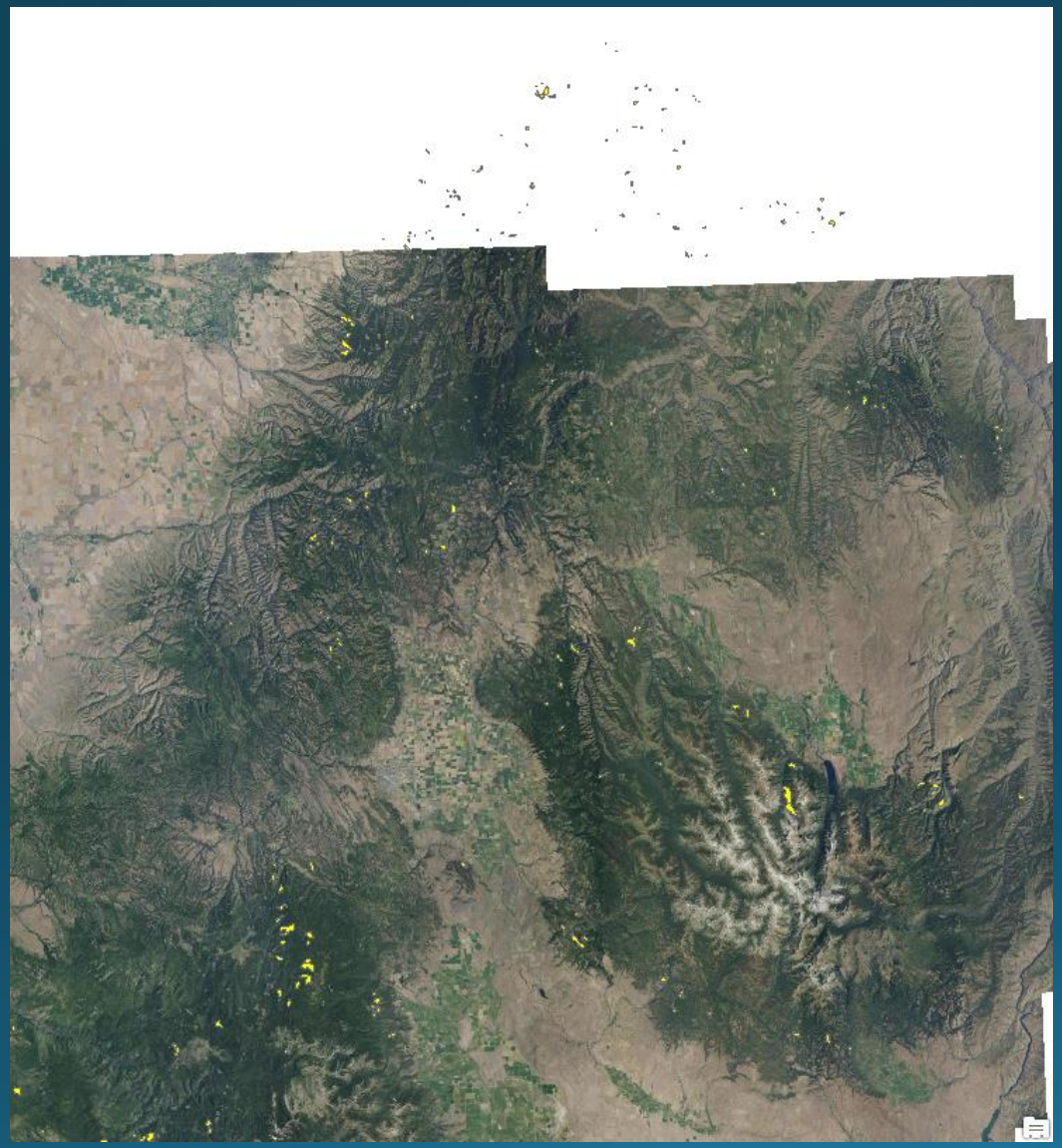


2014

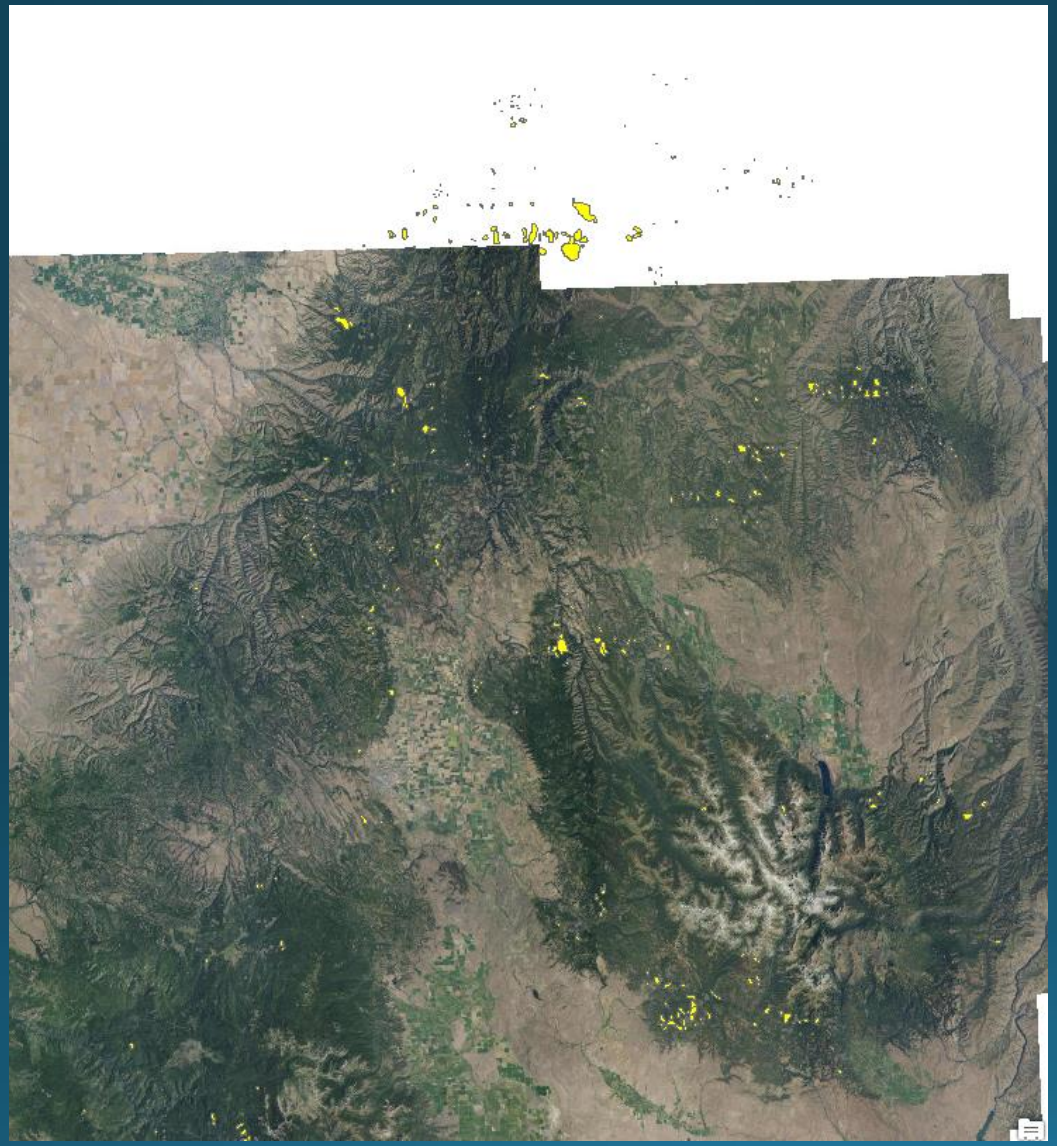


2015

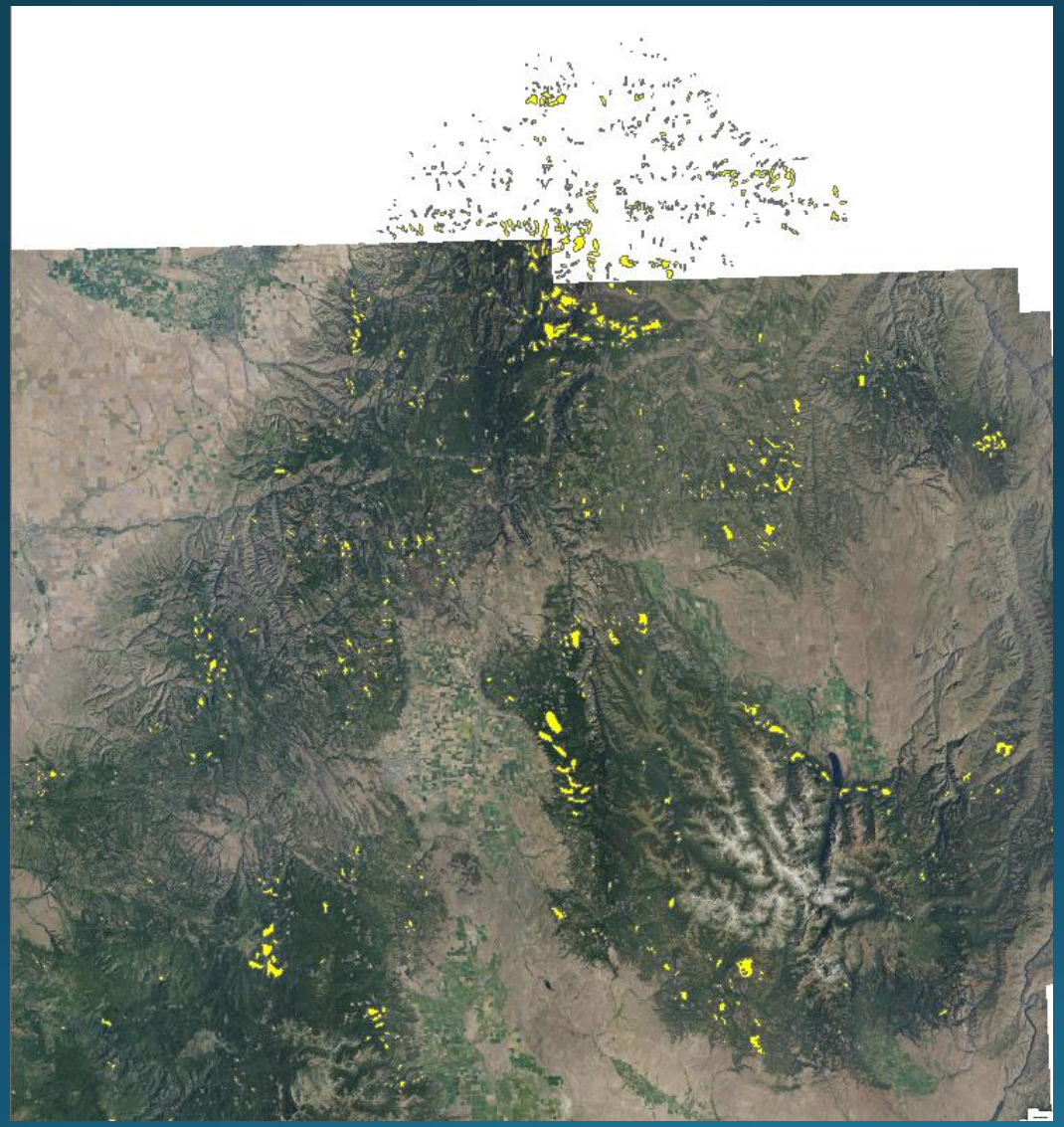
2016



2017



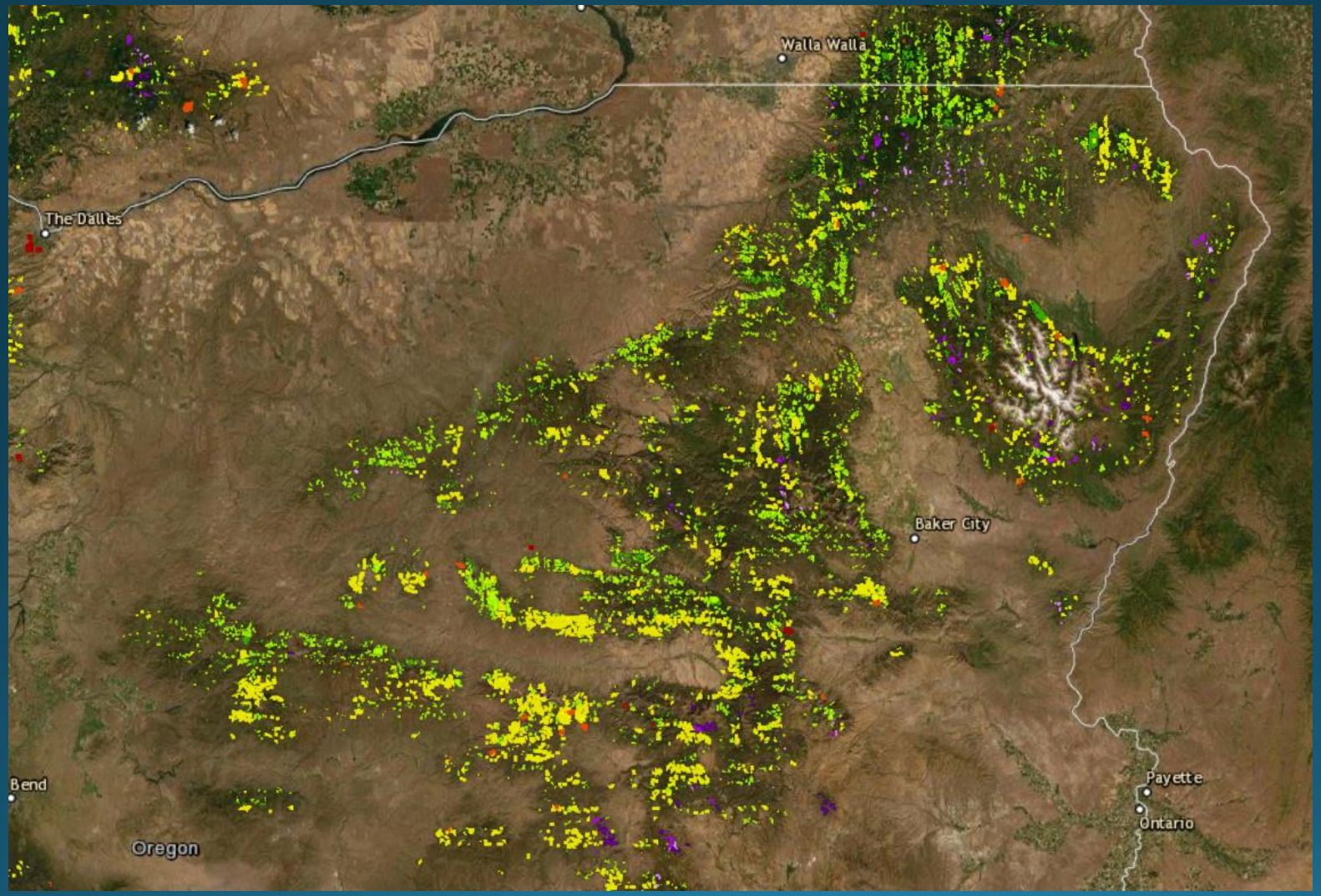
2018



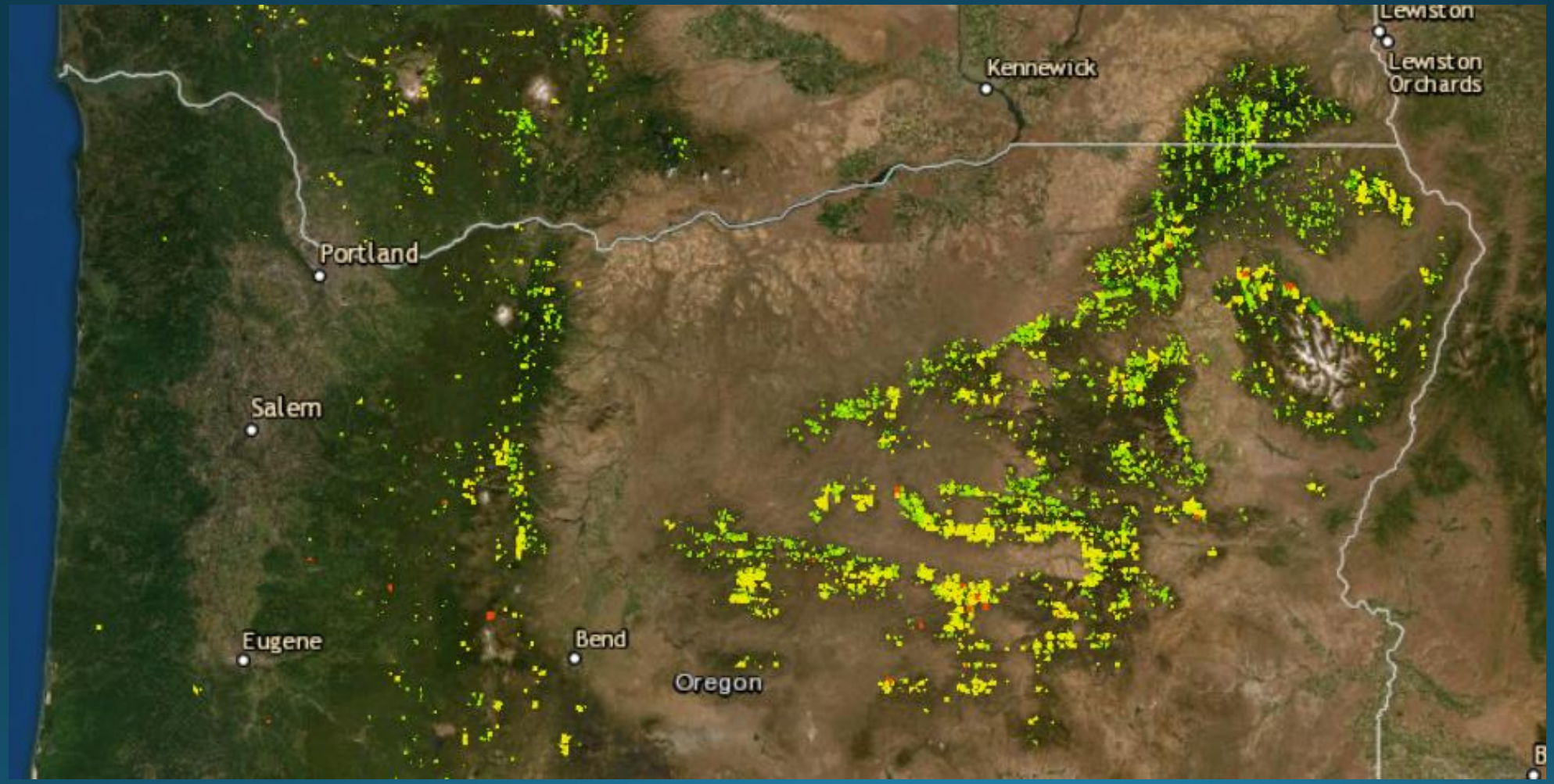
What will the 2019 Draft ADS Map look like?

- Hint: The evening news said the drought is over…
- The answer:
- It depends.

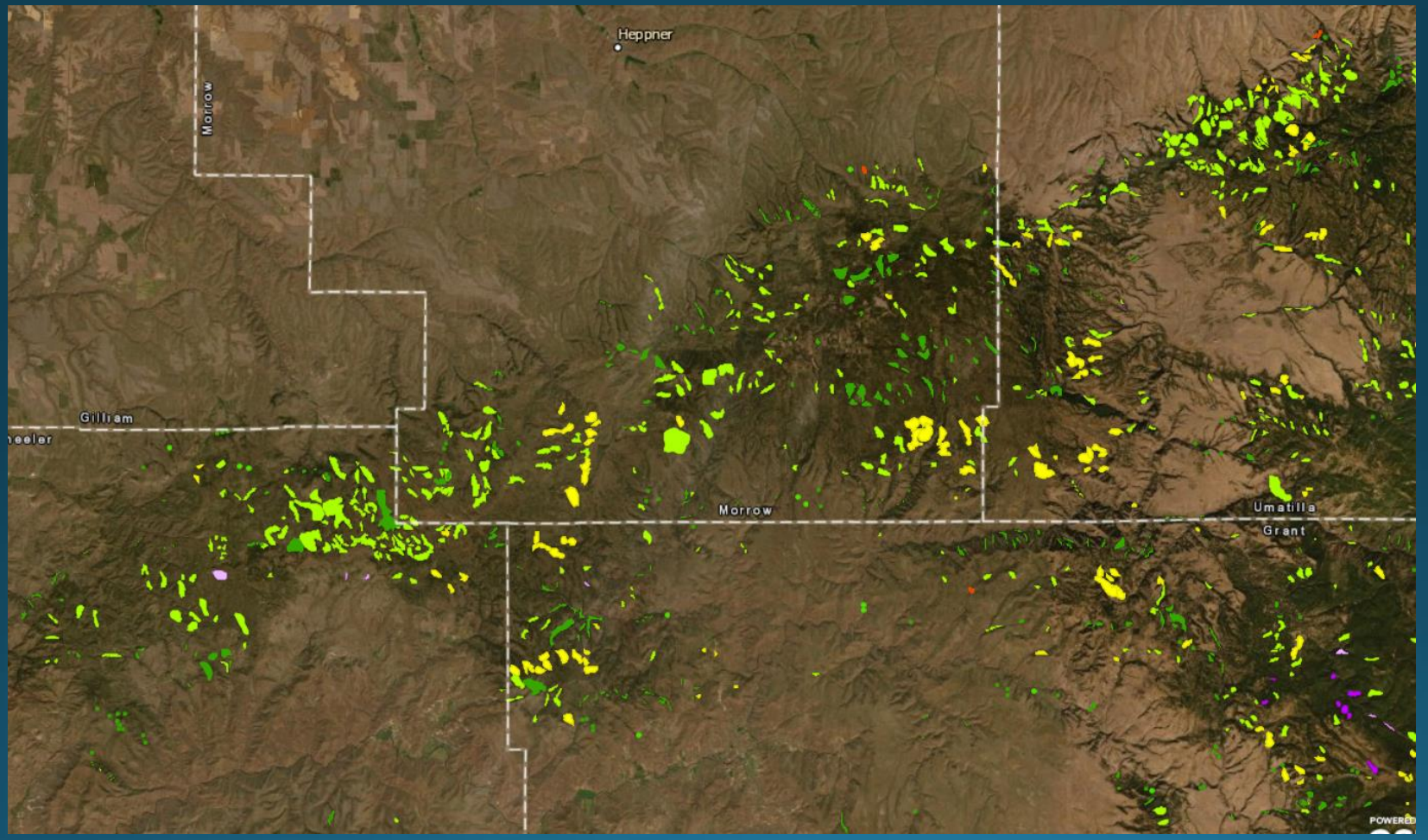
2019 Draft ADS for BMFI&DSC



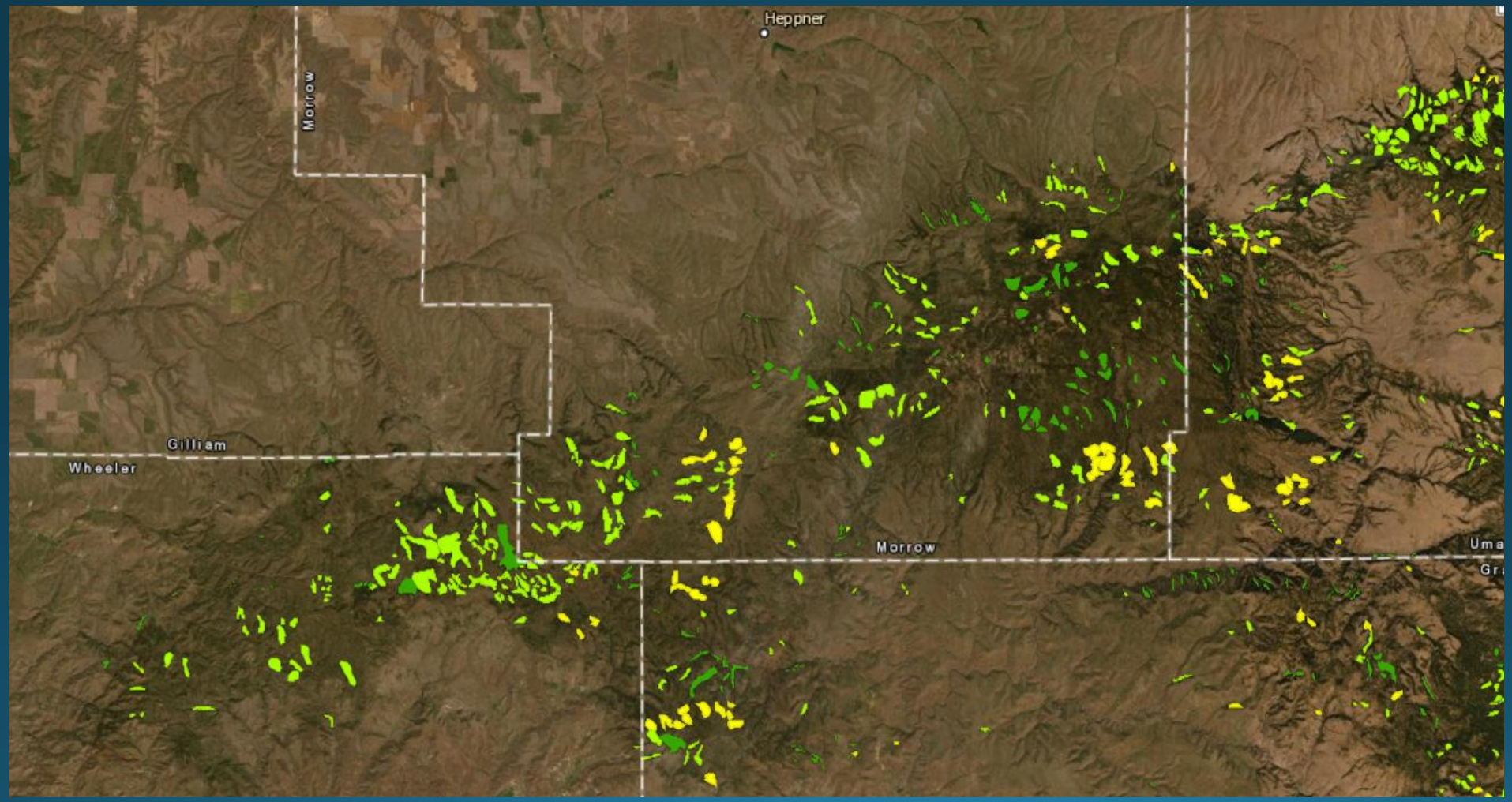
2019 Draft ADS for Fir Engraver



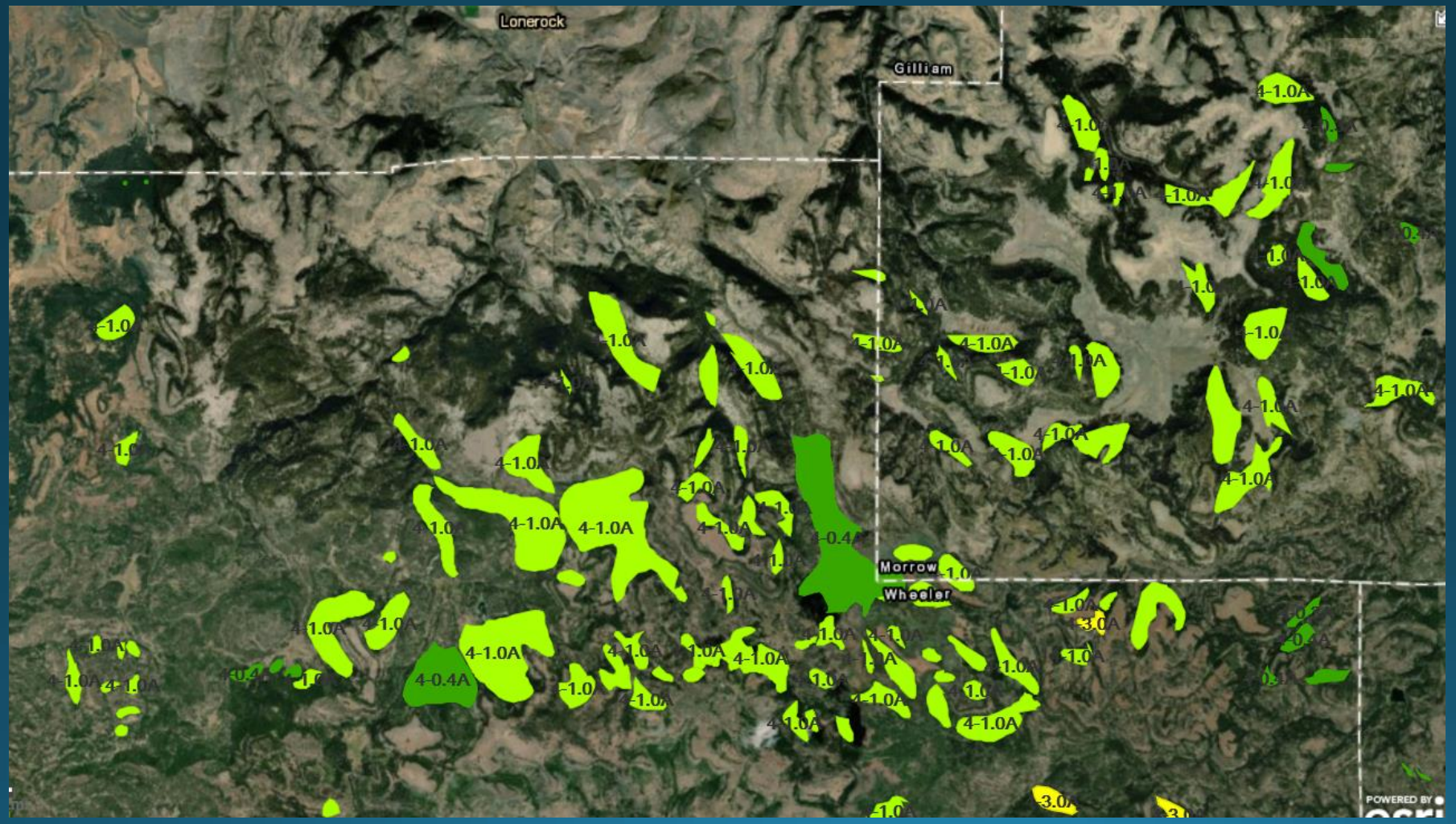
2019 Draft ADS South of Heppner



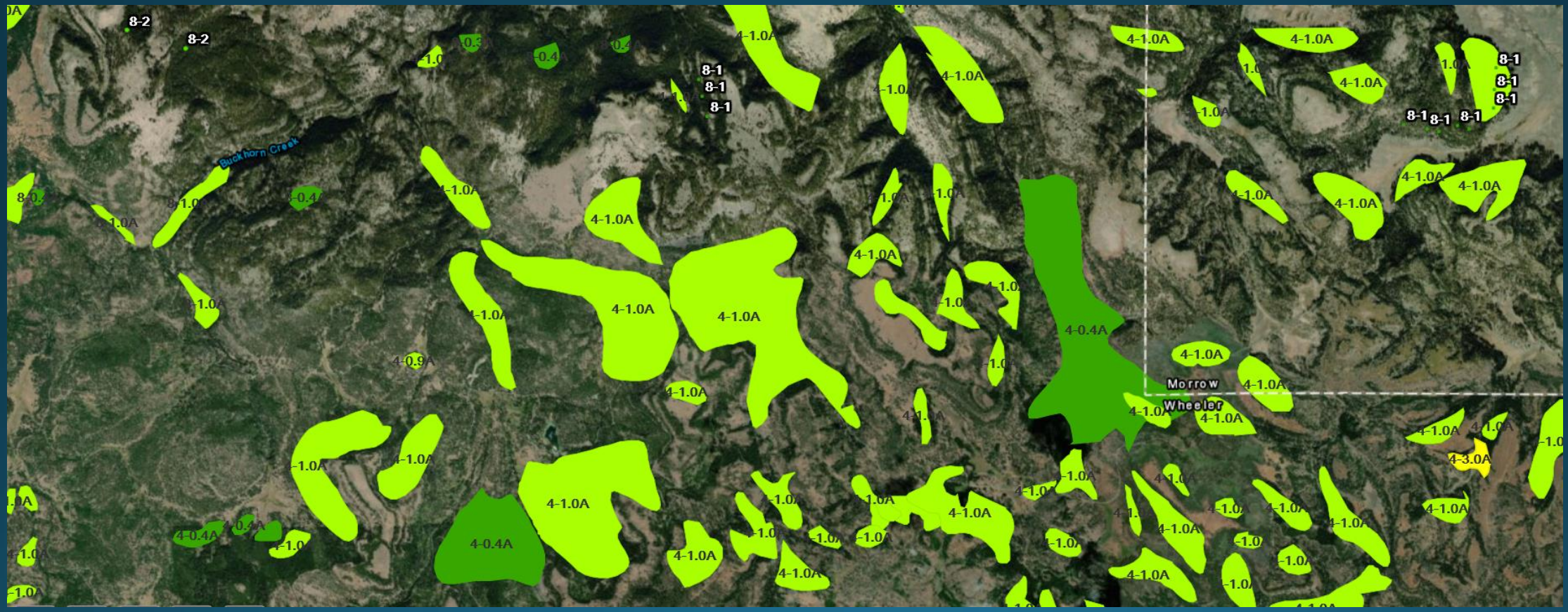
2019 Draft ADS for Fir Engraver South of Heppner



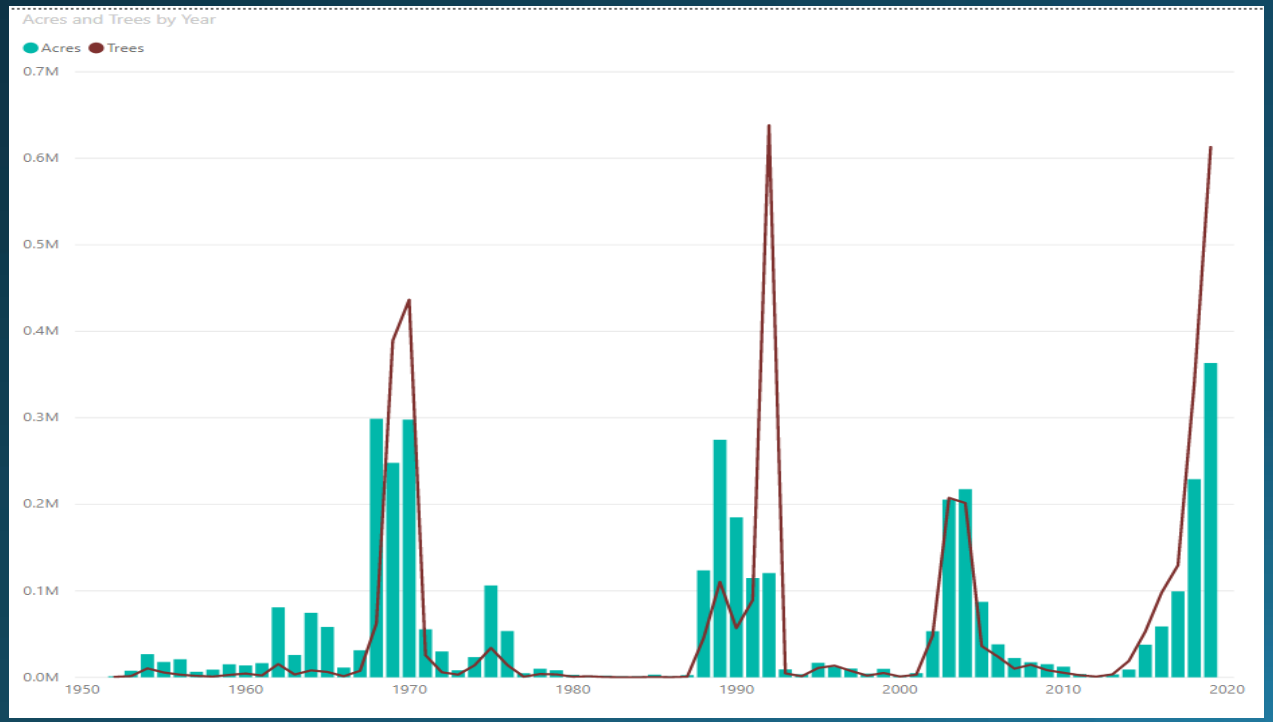
2019 Draft ADS for Fir Engraver



2019 Draft ADS in Vicinity of West End

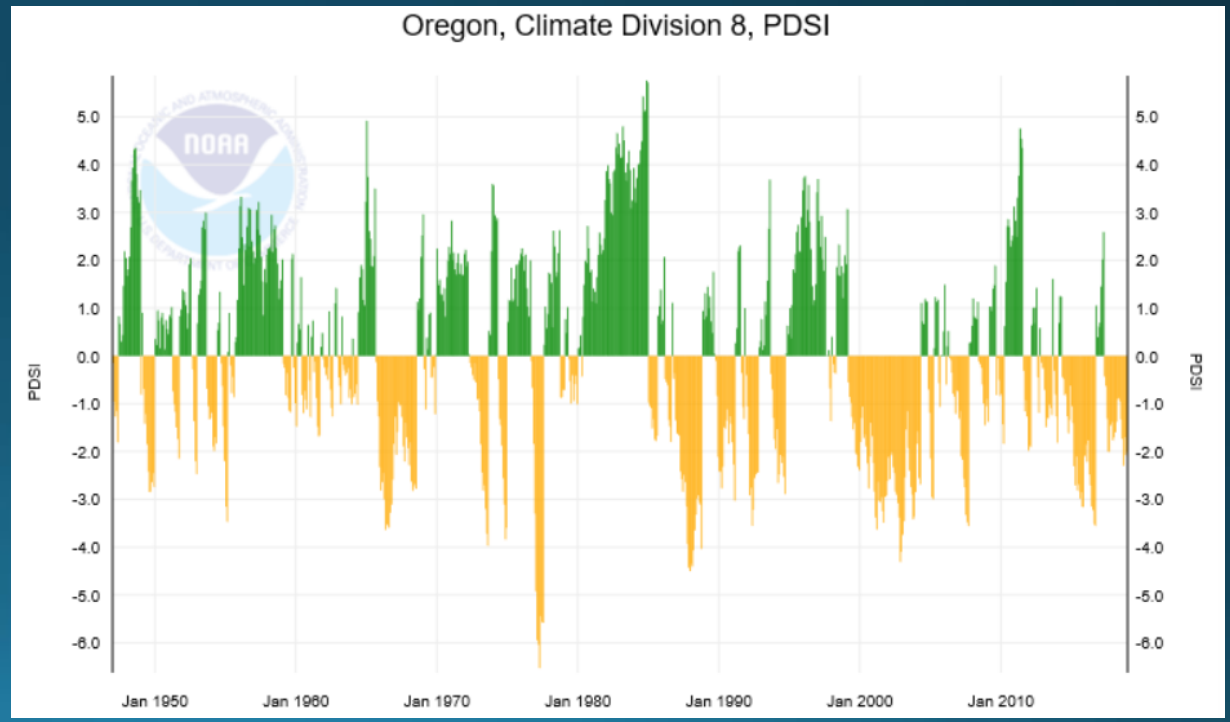


Fir Engraver Mortality 1947-2019



Palmer Drought Severity Index 1947-2019

NOAA National Centers for Environmental information, Climate at a Glance: Statewide Time Series, published October 2019, retrieved on November 5, 2019 from https://www.ncdc.noaa.gov/cag/



Walter Climate Diagrams